Lattice design and particle tracking

Lattice design

- triplet, singlet, and doublet lattice

Particle tracking

- 6D tracking with PTC (including acceleration)

Shinji Machida, KEK

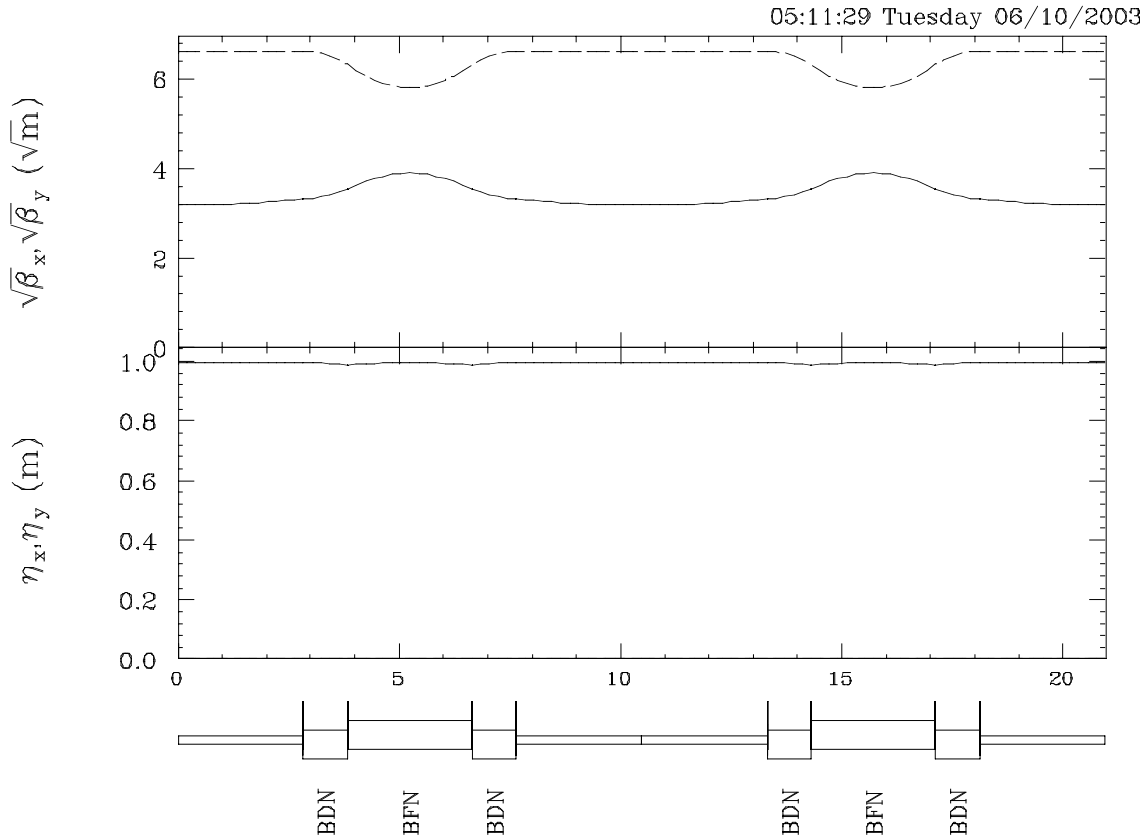
Nufact03, Columbia, 2003.6.10

Constraints (as of November 2002 except radius)

Momentum range:	10 to 20 GeV/c
Orbit excursion:	0.25m or less
Vertical beam size:	0.15 m (full)
Physical emittance:	300 pi mm-mrad
Machine radius:	120m or less
Maximum bend field:	8T (6T is preferred)

Triplet lattice (NufactJ proposal in 2001)

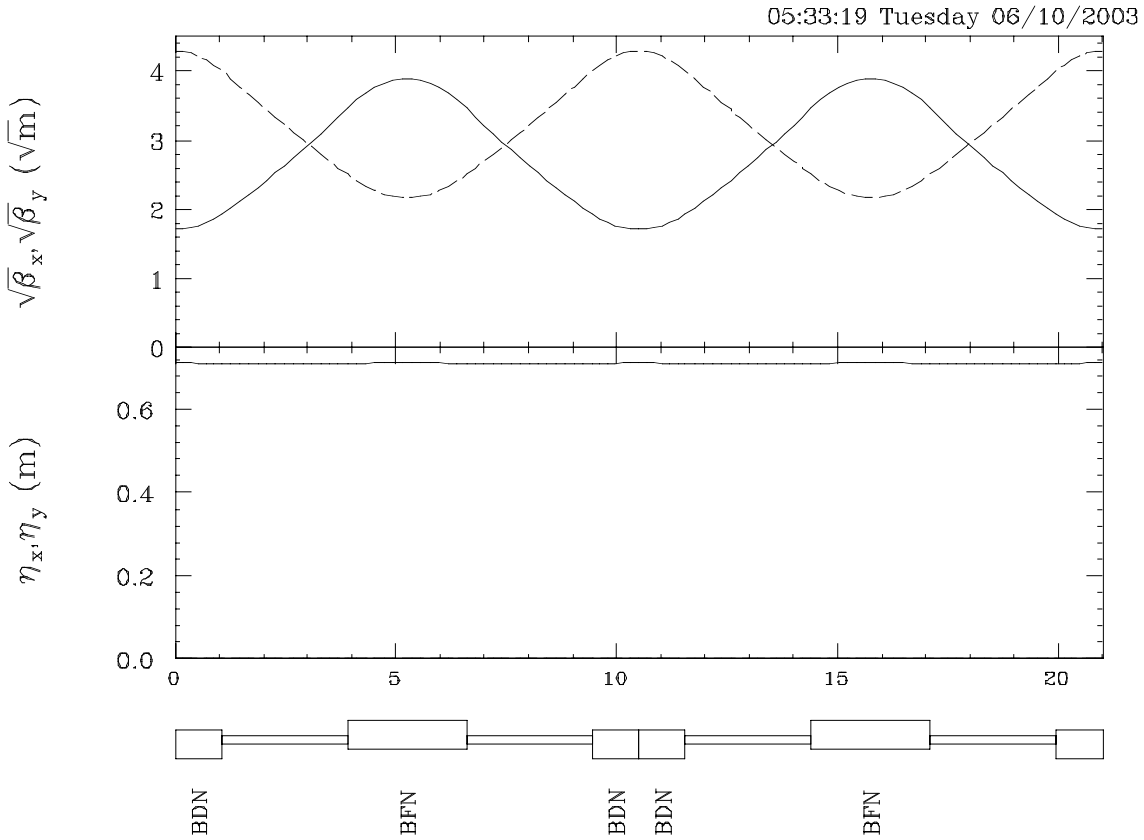
small phase advance in vertical



Singlet (FODO) lattice

not much different in horizontal and vertical phase advance

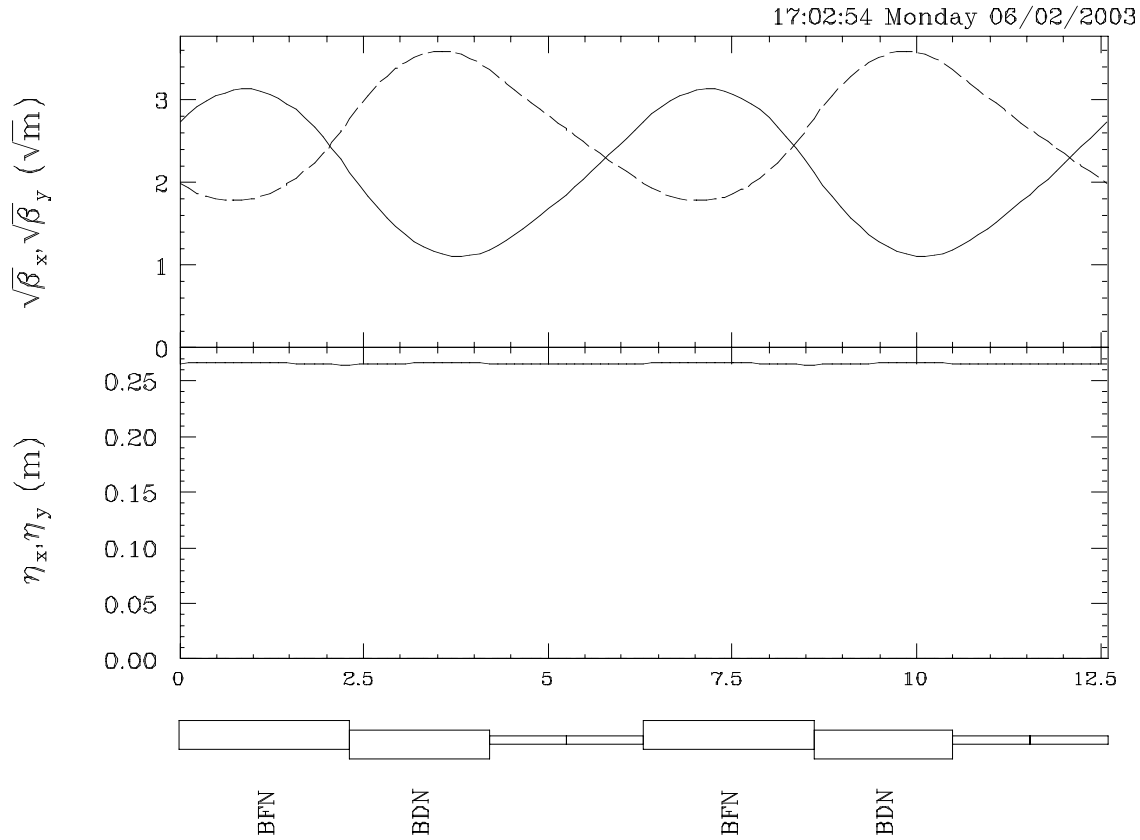
straight length is a half of triplet lattice



Doublet lattice

similar beta functions to singlet lattice

similar straight length of triplet lattice



Singlet, triplet vs. doublet

Triplet has smaller phase advance in vertical.

Singlet (FODO) focusing makes each straight section shorter.

-> average radius tends to be larger or magnet fields higher.

Doublet makes straight section as long as triplet.

Focusing is similar in both planes as singlet.

New candidates in 2003

	R(m)	N	k	dR(m)	B(T)	E(MV/m)	Trn	SS(m)
Singlet or FODO								
Type 1 :	200	180	670	0.206	5.86	.75	151	.75
Type 2 :	120	120	330	0.251	7.73	.83	221	.57
Doublet								
Type 3 :	120	120	450	0.18	6.	.83	22	2.
Type 4 :	120	180	800	0.10	8.	.83	22	1.4

Tracking with PTC

Polymorphic Tracking Code (PTC) by Etienne Forest

Ref. KEK Report 2002-3, also CERN-SL-2002-044 (AP)

- Read field map data (TOSCA, measured or fake one)
- Kick-Drift-Kick code
- Exact for any dp/p

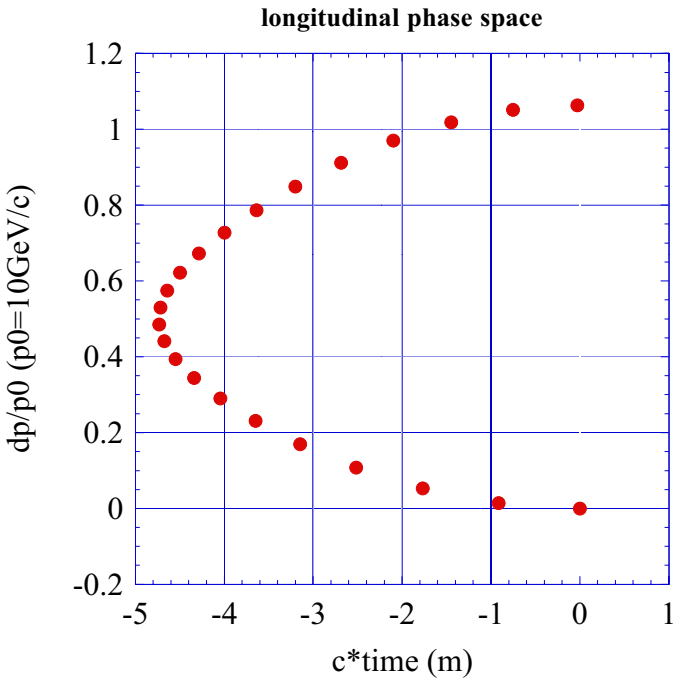
For example, if we take p0=0.3GeV/c, the momentum range of the final ring is dp/p=33.3 to 66.7. We plan to track entire cascade with single p0.

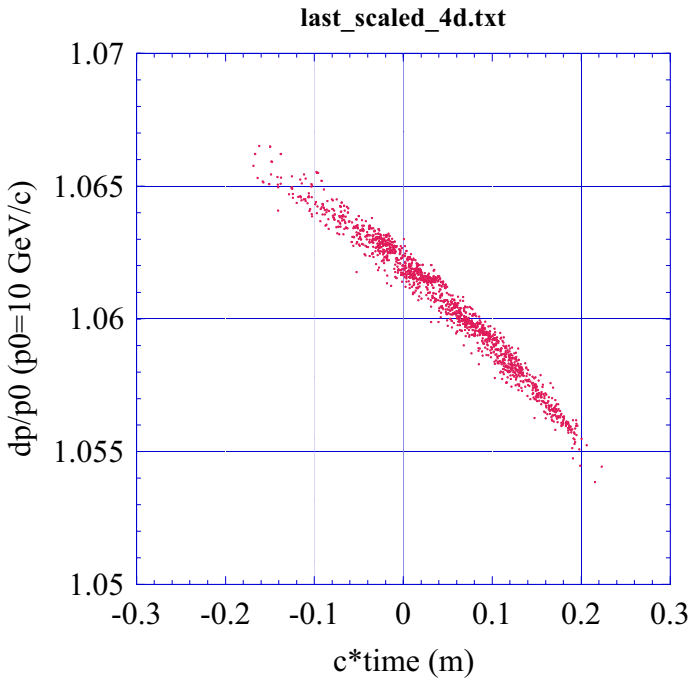
Tracking from 10 GeV/c to 20 GeV/c with PTC (p0=10GeV/c)

"soft-edge" model,

B=B0*(r_r0)^k plus enge function at both ends

Type 2 lattice is used

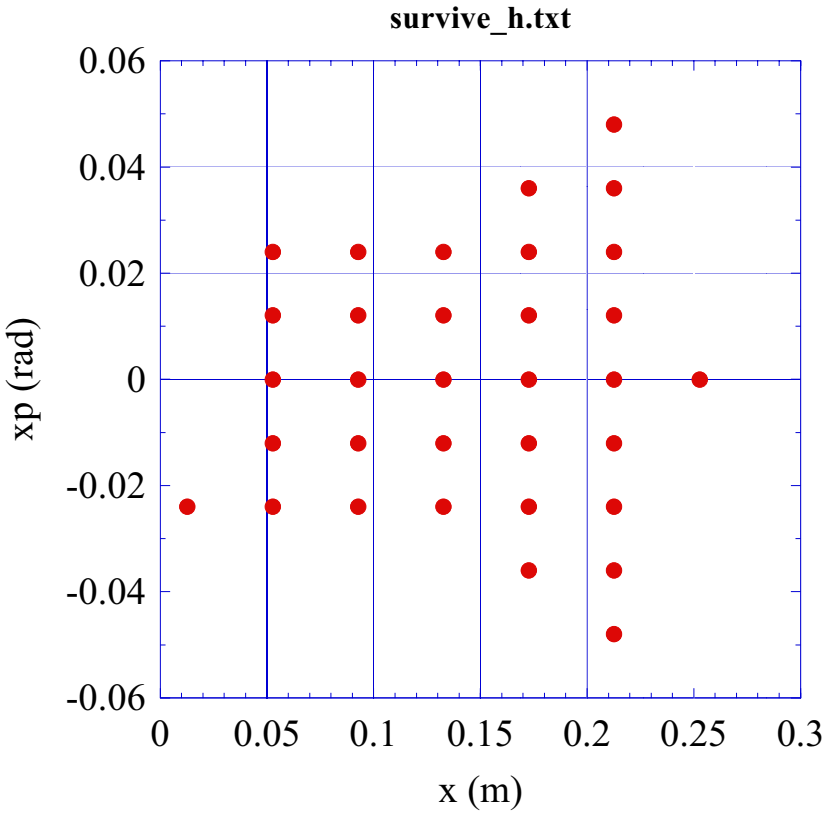




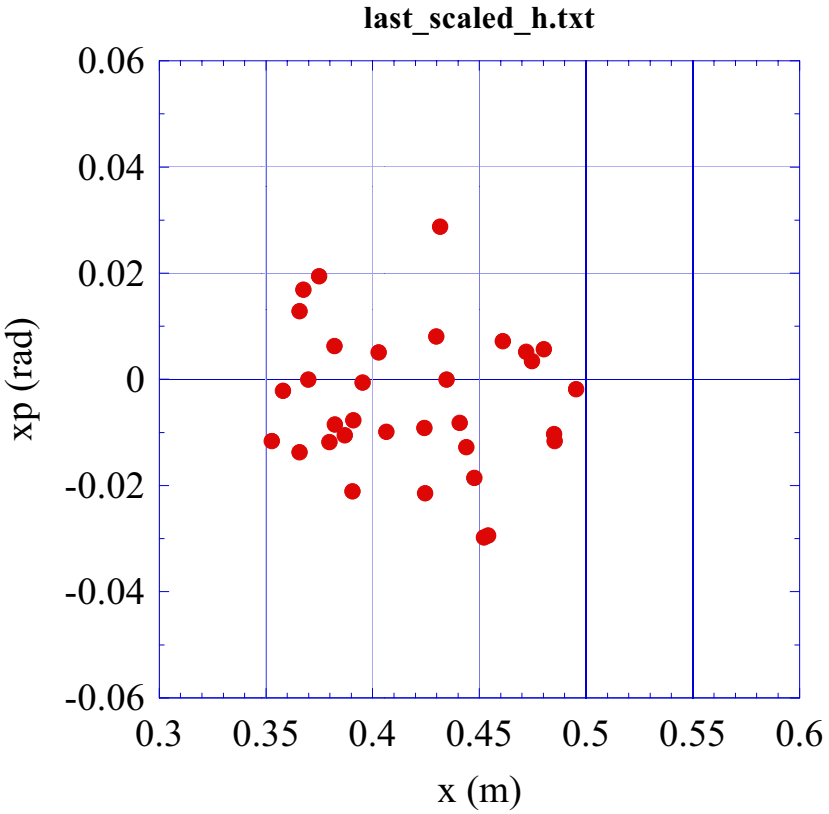
RF bucket has length of +-2 pi (= +-6.28 m)

Horizontal acceptance with acceleration

at turn = 0

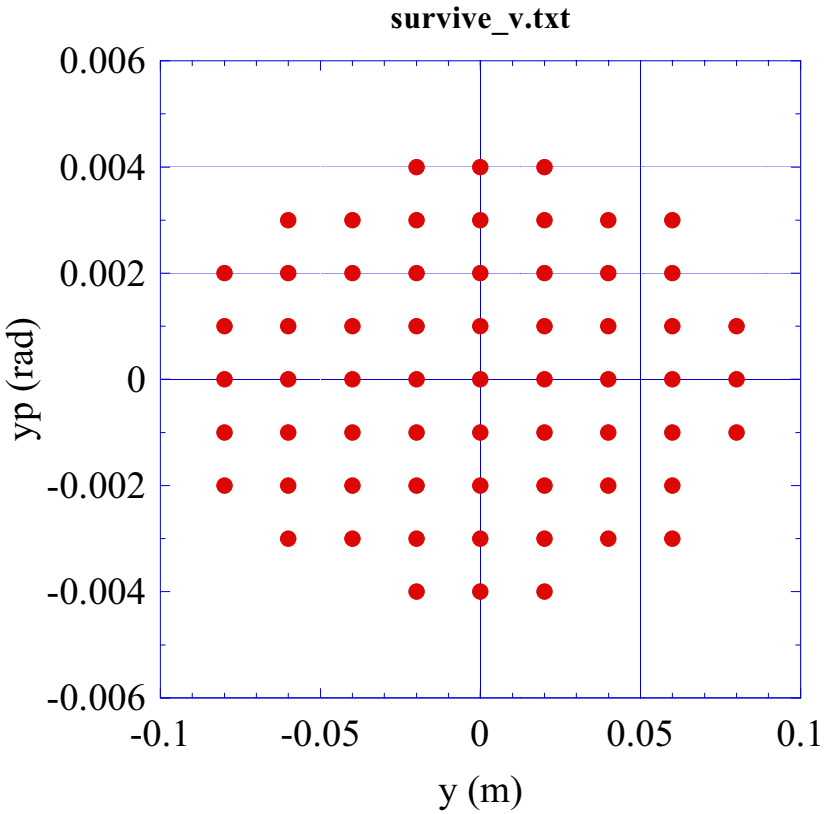


at turn = 22

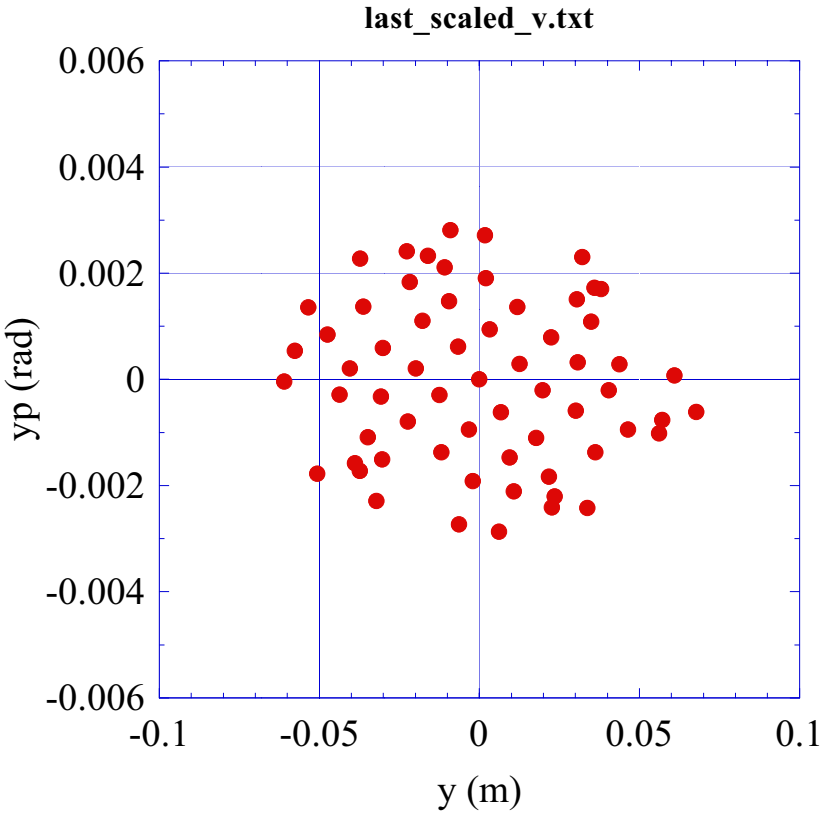


Vertical acceptance with acceleration

at turn = 0



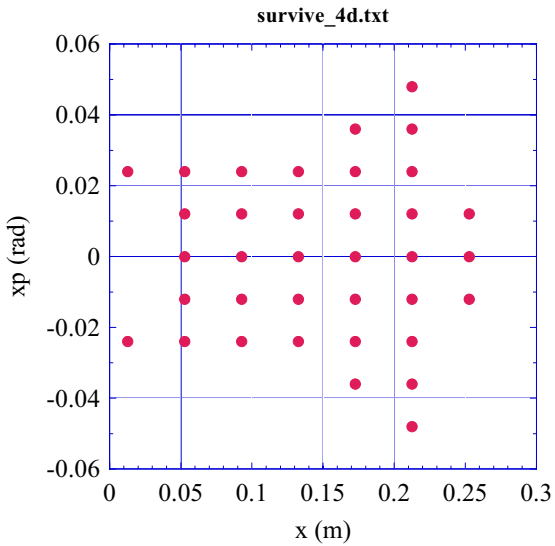
at turn = 22

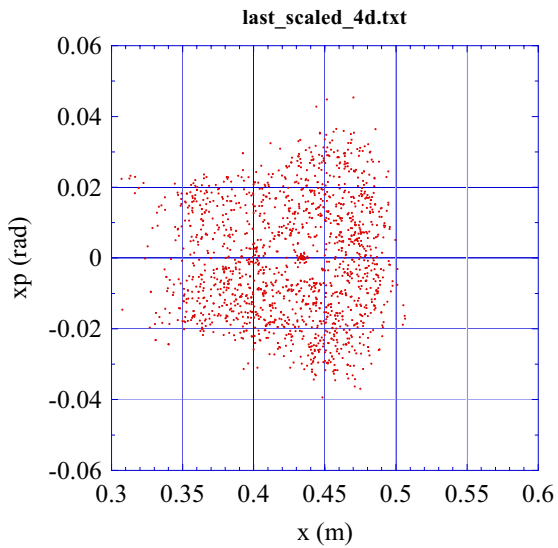


Transverse 4D acceptance with acceleration

survival rate = 1682/14641

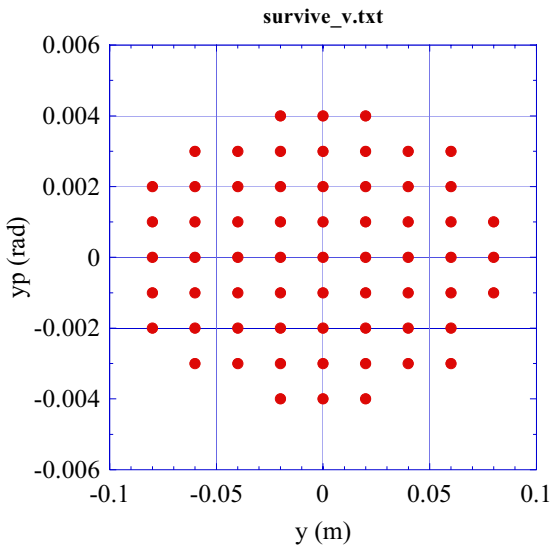
in 4D

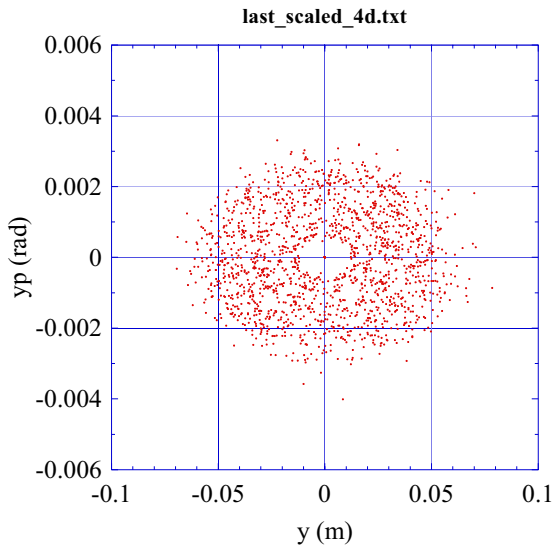




vertical acceptance

= 320 pi mm-mrad





Coupling between horizontal and vertical

Surviving ratio

Horizontal only	33/121
Vertical only	63/121
	33*63/121*121
	= 2079/121*121

Hor. and Ver. 1682/121*121

Reduction due to a whole 4D tracking is 20%.

Summary

Singlet and triplet FFAG lattice is designed with R=120m and 6 (or 8T) superconducting magnets.

6D tracking is performed with PTC based on soft edge fringe field. Adequate transverse 4D acceptance is obtained.